



Original Communication

Stature estimation from the length of the sternum in South Indian males: A preliminary study[☆]

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ABSTRACT

Estimation of stature is one of the important initial steps during forensic analysis of human skeletal remains. The aim of the present study was to derive a linear regression formula for estimating stature of adult South Indian males from the length of the sternum. The study included 35 male sternums of South Indian origin dissected from cadavers during medico-legal autopsies. The linear regression equation [Stature = $117.784 + (3.429 \times \text{Sternal length})$] was derived to estimate the stature from the length of the sternum. The correlation coefficient was 0.638. The standard error of the estimate was 5.64 cm. This preliminary study concludes that the length of the sternum can be used as a tool for stature estimation in adult South Indian males.

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1. Introduction

Establishment of the identity of human skeletal remains carries tremendous forensic significance.¹ Stature provides one aspect of an individual's physiognomy, and its determination is one of the important initial steps during forensic analysis of skeletal remains.² Stature may be estimated by means of various anthropometric measurements of the skeleton.^{3–14} Such estimation is based on the relations between skeletal elements and stature.¹⁵ It is an established fact that stature bears a direct relation to the length of various bones, and linear regression equations are de-

rived to estimate stature from the length of a bone. As a rule of thumb, larger the skeletal element, taller the individual is. This suggests that, theoretically, length of any bone of an individual reflects that individual's stature.

Forensic anthropology which mainly focuses on the identification of skeletal remains, in a legal context has stood the test of time over a century now. The examination of long bones provides the most accurate stature estimation potential. However, long bones may not be present in every instance, necessitating the possible use of other skeletal elements such as the sternum when present.^{16–18} Telkka opined that every racial or ethnic group would need a different linear regression equation, and region wise studies are very essential as racial or ethnic variations arise in different geographic regions.¹⁹ Linear regression equation to estimate stature from the length of the sternum of adult males of South Indian origin is not documented, and hence, this study is being undertaken.

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2. Material and methods

The present study was conducted at the Department of Forensic Medicine, Kasturba Medical College, Manipal, South India in 2002–2003. Thirty five intact sternums belonging to adult males of South Indian origin aged between 20 and 83 years autopsied at the aforementioned centre comprised the study material. The age of the individuals autopsied was retrieved from the inquest documents furnished by the police and confirmed on interviewing the legal heirs. The bodies that were decomposed, charred, mutilated and with physical anomalies affecting the stature were excluded from the study.

The body was placed in supine position on a flat, hard surfaced autopsy table, with the knee and hip joints extended, and the neck and feet in neutral position. The cadaveric length (stature) was measured between the vertex of the head and the heel using a steel measuring tape according to the technique described by Nagesh and Kumar.²⁰ The dissected sternal plates were macerated in a solution made of two parts of water and one part of sodium hypochlorite solution containing 5% chlorine (Nice Chemicals Pvt. Ltd., Cochin, India), and then dried. The midline combined length of the manubrium and the mesosternum was measured from the incisura jugularis (central suprasternal notch) to the mesoxiphoid junction in the mid-sagittal plane using vernier calipers to the nearest millimeter according to the technique described by Ashley.²¹ In sternums with ossified proximal end of xiphoid process, the lower end of the two lateral articular demifacets for the seventh costal cartilage along the lateral borders of the mesosternum formed the landmark to differentiate the mesosternum from the xiphoid process.²² The xiphoid process was not taken into consideration in the present metric study because of high variability of its length.²² All the measurements were recorded by one author to minimize the error in measurement.

The data were analysed using SPSS, version 10.1, statistical analysis program (SPSS Inc., Chicago, IL, USA), to derive a linear regression equation for stature estimation. To assess the correlation between stature and the length of the sternum, Pearson's correlation coefficient was calculated and its significance was tested by Student *t* test. *P*-value of less than 0.05 was considered significant.

3. Results

Mean (\pm S.D) age of the study sample was 38.94 (\pm 13.96). Except for three individuals, the study sample belonged to 20–55 years age group. Stature ranged from 148 cm to 181 cm with a mean (\pm S.D) of 166.47 (\pm 7.22). The length of the sternum ranged from 10.60 cm to 16.10 cm with a mean (\pm S.D) of 14.20 (\pm 1.34). The linear regression equation [Stature = $117.784 + (3.429 \times \text{Sternal length})$] was derived to estimate the stature from the length of the sternum. The correlation coefficient was 0.638. The standard error of the estimate was 5.64 cm. The results derived from the present study were statistically significant ($P \leq 0.001$).

4. Discussion

Identification of human remains is of paramount importance in forensic practice.²³ The probabilities and possibilities of apprehending a criminal are greatly increased once the identity of the victim has been established. Chapter-5 entitled 'Harry Dobkin and the skeleton in the cellar', in "Forty years of murder", an autobiography by Professor Keith Simpson, is an illustration to show that identification of stature in human skeletal remains is pivotal during trial in the court of law. The identity of the deceased was established as that of Rachel Dobkin. Her husband, Harry Dobkin was

charged with the murder of his wife, and was convicted. During trial, the anthropometric evidence in relation to the stature of the victim was decisive.²⁴

Anthropometric technique has been employed to estimate stature for over a 100 years. With the increasing frequency of mass disasters, estimation of stature from fragmented and dismembered human remains has created problems in the investigation of the identity of some of the victims. Most methods of estimating stature from the skeleton are based on the long bones of the lower and upper extremities. Sternum is one of the bones that could be used to determine stature, when skeletal remains are recovered without the limbs being present.

In the South Indian male population, linear regression equations to estimate stature from various parameters like the vertebral column length, hand dimensions, middle finger length and the coronal suture length are studied in the recent past. Nagesh and Kumar estimated stature of South Indian males from the vertebral column length.²⁰ Rastogi et al. estimated stature of South Indian males from hand dimensions²⁵ and the middle finger length.²⁶ Rao et al. attempted to estimate stature of South Indian males from the length of the cranial sutures.²⁷ The very fact that such equations to estimate stature from the length of the sternum are not available for the South Indian male population, underlines the importance of the present study.

In the present study wherein stature is estimated from the length of the sternum in South Indian males, mean (\pm S.D) of the stature was 166.47 ± 7.22 cm. This is comparable with other most recent studies done in the South Indian male population wherein Nagesh and Kumar²⁰ reported 166.01 ± 6.90 cm, Rastogi et al.^{25,26} reported 171.95 ± 7.05 cm and Rao et al.²⁷ reported 166.83 ± 6.74 cm.

The correlation coefficient in our study was 0.638. The length of the sternum showed better correlation coefficient than hand breadth, coronal suture length and sagittal suture length while estimating stature in South Indian males. Rastogi et al.²⁵ reported a correlation coefficient of 0.594 and 0.592 while estimating stature from right hand breadth and left hand breadth, respectively, in South Indian males. Rao et al.²⁷ reported a correlation coefficient of 0.363 and 0.090 while estimating stature from coronal suture length and sagittal suture length, respectively, in South Indian males. The hand length and the middle finger length showed a better correlation coefficient than the length of the sternum in South Indian males. Rastogi et al.²⁵ reported a correlation coefficient ranging from 0.705 to 0.734 while estimating stature from hand length. Another study by Rastogi et al.²⁶ reported a correlation coefficient of 0.696 and 0.679 while estimating stature from right middle finger length and left middle finger length, respectively, in South Indian males. In addition, length of the various segments of the vertebral column showed a better correlation coefficient than the length of the sternum. Nagesh and Kumar²⁰ reported a correlation coefficient ranging from 0.649 to 0.776 while estimating stature from the various segments of the vertebral column in South Indian males.

In our study, the standard error of estimate was 5.64 cm. The standard error of estimating stature from the length of the sternum is lesser than that while estimating stature from hand breadth and the cranial sutures. Rastogi et al.²⁵ reported a standard error of estimate of 5.71 cm and 5.73 cm while estimating stature from right hand breadth and left hand breadth, respectively, in South Indian males. Rao et al.²⁷ reported a standard error of estimate of 5.67 cm and 9.42 cm while estimating stature from coronal suture length and sagittal suture length, respectively, in South Indian males. The standard error of estimating stature from hand length ranged from 4.83 cm to 5.04 cm in South Indian males²⁵ which is lesser than that while estimating stature from the sternal length. The standard error of estimating stature from right middle finger

length and left middle finger length is 5.10 cm and 5.23 cm, respectively, in South Indian males²⁶ which is lesser than that while estimating stature from the sternal length. In addition, except for the cervical segment of the vertebral column, the standard error of estimating stature from the length of the complete vertebral column and various other segments of the vertebral column²⁰ is lesser than that while estimating stature from the sternal length in South Indian males.

5. Conclusion

Stature is an important parameter in determining the partial identity of mutilated bodies and skeletal remains. In our study, the length of the sternum was found to be well correlated to stature in the South Indian adult male population. The present study concludes that the sternum can be a useful tool in the estimation of stature. Our study indicates that stature can be predicted from the sternal length by linear regression analysis. The study confined to the South Indian population is useful to estimate stature when the sternum is subjected for medico-legal skeletal examination.

Studies on a larger male sample in this region are needed to further confirm the findings of our preliminary study. Similar studies applicable to the adult South Indian female population are proposed. In addition, similar studies are proposed in other population groups where morphometric analysis of the sternum is not yet done to derive regression equations that may help in stature estimation.

Conflict of Interest

None declared.

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Ethical approval

None declared.

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